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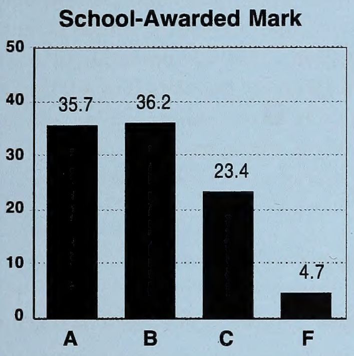
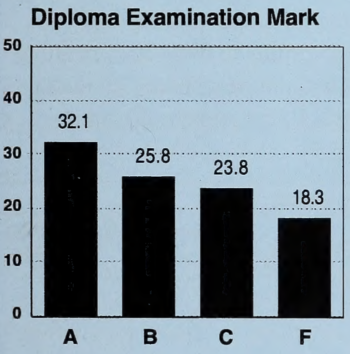
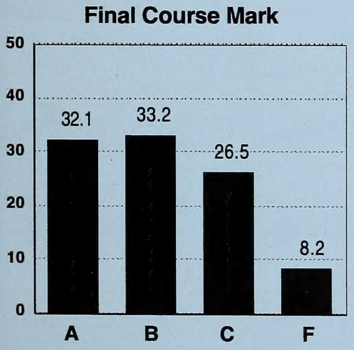
Physics 30

Diploma Examination Results
Examiners' Report for June 1994







The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the June 1994 administration of the Physics 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been mailed to schools and school jurisdiction offices. An annual provincial report containing a detailed analysis of the combined January, June, and August results is published each year.

Description of the Examination

The Physics 30 Diploma Examination consists of three parts: a multiple-choice section of 42 questions worth 60%, a numerical-response section of seven questions worth 10%, and a written-response section of four questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 4 499 students in Alberta who wrote the June 1994 examination. This represents a decrease of 683 compared to June 1994. The decrease is partially accounted for by the fact that 623 students received final course marks in the revised (pilot) Physics 30 course.

- 91.8% of the 4 499 students achieved the acceptable standard (a final course mark of 50% or higher).
- 32.1% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Overall, student achievement in Physics 30 was satisfactory. Students' graphing skills continued to improve, and they showed a good understanding of course content. Many students experienced difficulty when required to transfer their knowledge of course content to real-life situations.

The average examination mark achieved by the female population (36.7%) was 68.2% and by the male population (63.3%) was 67.3%.

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Provincial Averages

- The average school-awarded mark was 72.3%.
- The average diploma examination mark was 67.7%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 70.4%.

Approximately 10.3% of the students who wrote the examination in June 1994 and received a school-awarded mark had previously written at least one other Physics 30 Diploma Examination. This subpopulation of 465 students achieved lower results (61.7%) than the population of 4 034 students whose first writing of a Physics 30 examination (68.3%) was in June 1994. However, the group of students who rewrote the physics examination increased their score, on average, from 53.4% to 61.7%.

Results and Examiners' Comments

Machine-Scored Blueprint (Multiple Choice & Numerical Respon

Each question on the examination is classified in two ways: according to the curricular content area being tested and according to the cognitive leve demanded by the question. The examination blueprints illustrate the distribution of questions in June 1994 according to these classifications. I the machine-scored columns, numbers without parentheses are multiple-choice questions and those in parentheses ( ) are numerical-response questions.

	Machine Scored			
Course Content	**Knowledge**	**Comprehension and Application**	**Higher Mental Activities**	**Examination Emphasis (%)**
Light	1, 2, 3, 5	4, 6, (1)	7, (2)	13
Electric and Magnetic Fields	10, 11, 14, 17	8, 9, 12, 13, 15, 18, 19, 20, (3), (4)	16	21
Electromagnetic Radiation	21, 22, 27	23, 24, 25, 26, 28	34, (6)	14
Structure of Matter	30, 33, 37	29, 31, 35, 36, (5)	32	13
Modern Physical Theories	40, 41, 42	38, 39, (7)		9
Examination Emphasis (%)	24	37	9	70

Subtest

When analyzing detailed examination results, please bear in mind that subtest results **cannot** be directly compared.

Results are in average raw scores.

Machine scored: 35.39 out of 49

Course Content
- Light: 6.58 out of 9
- Electric and Magnetic Fields: 10.96 out of 15
- Electromagnetic Radiation: 6.77 out of 10
- Structure of Matter: 6.61 out of 9
- Modern Physical Theories: 4.47 out of 6

Process Skills: 7.84 out of 15
- Multiple-choice questions 6, 7, 9, 12, 16, 18, 19, 24, 26, 32, 34, 36 and numerical-response questions 1, 2, and 6.

Cognitive Levels
- Knowledge: 11.97 out of 17
- Comprehension and Application: 19.46 out of 26
- Higher Mental Activities: 3.98 out of 6

ubtest

eacher Scored: 11.94 out of 21

Written-Response Questions
- Question 1: 3.09 out of 5
- Question 2: 2.44 out of 4
- Question 3: 2.44 out of 5
- Question 4: 3.97 out of 7

Teacher-Scored Blueprint (Written Response)

Question Number	Teacher Scored Question Description (Concept, Cognitive Levels, and Process Skills)	Examination Emphasis (%)
1	Using a given stopping voltage, determine the maximum kinetic energy of photoelectrons. Calculate the speed of the fastest photoelectrons. From formula available within the data booklet, derive an equation that can be used to determine the radius of curvature of the fastest photoelectrons. Substitute into derived formula and calculate the value for R, the radius.	7
2	Calculate the centripetal force using a value of R as determined from the centre of the Earth, and by converting the orbital period from minutes to seconds calculate the speed of the satellite. Equate centripetal force to gravitatiional force and manipulate to derive an equation for calculating the mass of the Earth.	6
3	Substituting values from the line of the graph for rise and run, determine the slope of a straight-line graph. Explain how the units of slope are obtained and determine the rest mass of the accelerated particles.	7
4	Describe the materials needed, procedures and values to be measured, derive equations, and perform calculations that are needed to find the range of frequencies of the visible colours from a light source that is not monochromatic.	10
Examination Emphasis (%)		30

his examination has a balance of questions and difficulties. It is designed so that students capable of achieving the ceptable standard will obtain a mark of 50% or higher and students capable of achieving the standard of excellence ill obtain a mark of 80% or higher. This examination included numerical-response questions, which students handled ry well. Students achieving the acceptable standard were expected to demonstrate good communication skills in the ritten-response section of examination, regardless of whether their answers were in calculation or written form.

ultiple Choice

uestion	Key	Difficulty*	Question	Key	Difficulty	Question	Key	Difficulty
1	C	79.1	15	D	67.7	29	C	67.9
2	B	74.8	16	B	60.0	30	A	59.4
3	B	53.6	17	A	58.0	31	C	86.7
4	D	82.2	18	D	56.6	32	D	54.7
5	C	54.9	19	D	55.7	33	A	43.3
6	A	44.9	20	A	78.9	34	D	54.2
7	D	76.6	21	D	52.8	35	C	56.1
8	C	81.4	22	D	60.9	36	D	56.3
9	C	60.6	23	B	85.6	37	D	92.1
10	A	71.5	24	D	69.9	38	A	67.9
11	D	78.7	25	A	86.7	39	B	91.6
12	A	40.4	26	A	62.6	40	B	47.0
13	B	62.3	27	B	58.0	41	B	60.5
14	A	80.0	28	B	45.2	42	D	70.0

ifficulty—percentage of students answering the question correctly

Use the following information to answer question 7.

While investigating a crime that took place in a dark alley, a police officer determined

—that the crime occurred under a red neon sign
—that the red neon sign emitted red light only

Four witnesses were interviewed and their comments recorded.

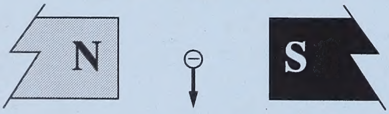
Witness	Time of Crime	Description of Criminal	Colour of Criminal's Jacket
1	2:00 A.M.	short and stout	yellow
2	2:30 A.M.	short and thin	blue
3	1:30 A.M.	tall and stout	green
4	1:00 A.M.	tall and thin	black

7. The criminal is **most** likely

A. short and stout
B. short and thin
C. tall and stout
• **D.** tall and thin

Use the following information to answer question 19.

Charge in a Magnetic Field



A negative charge moves through a magnetic field.

19. The charge will be deflected

A. toward the left side of the page
B. toward the right side of the page
C. out of the page
• **D.** into the page

All students were expected to demonstrate a high level of competence in calculations. Students achieving the standard excellence were expected to apply their knowledge to unusua problems and to use scientific generalizations effectively. Students' performance on the machine-scored sections of the examination was generally satisfactory. The average score fo the machine-scored sections was 72.22%. Students found the knowledge and single-step application questions to be the easiest.

For a complete breakdown of student responses by alternative for the multiple-choice questions, please refer to the school an jurisdiction reports. The following multiple-choice and numerical-response questions were selected for discussion because they exemplify the concepts and skills required to meet the acceptable standard and the standard of excellence.

Question 7: Students had to select which information was relevant for the question (observed colour of the criminal's jacket) and combine that with the other information given in the problem (red neon sign emitted red light only) to determin the correct description of the criminal. Of the students who achieved the standard of excellence, 89.6% answered the question correctly. Of the students who achieved the acceptable standard but not the standard of excellence, 78.9% answered the question correctly. Even 57.5% of the students who did not achieve the acceptable standard chose the correct answer. A total of 21.6% of all students chose an answer othe than D. This indicates that many students either do not understand why coloured objects are the colour they are or the are not able to transfer basic knowledge to real-life situations.

Question 19: Questions involving direction of force on charged particles in external magnetic fields or direction of an external magnetic field in order to obtain a particular deflectio on a charged particle continue to be difficult for many students Of the students who achieved the acceptable standard but not the standard of excellence, 56.8% answered the question correctly. Of the students who achieved the standard of excellence, 85.3% answered the question correctly. Of the students who did not achieve the acceptable standard, only 28.2% answered the question correctly. The difficulty lies predominantly within the confusion that many students have understanding whether or not to apply the right-hand or left-hand rule to charges within magnetic fields, electric fields, or current in a wire.

Numerical Response

Question	Answer	Difficulty*
1	14	76.0
2	1.73	85.4
3	15	76.1
4	9.07	80.0
5	9.28	92.8
6	1.61	62.6
7	6.68, 6.67	65.8

*Difficulty—percentage of students answering the question correctly

Most students correctly followed the instructions for filling in the answer sheet. Some students consistently rounded their answers to the incorrect number of digits, counted the decimal point as a digit, or filled in the zero instead of the decimal. In problems requiring the exponent to be recorded, $b \times 10^{-w}$, some students entered the value of b.

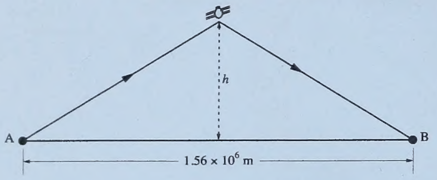
All seven questions discriminated well between those students who reached the acceptable standard and those who did not. Students achieving the acceptable standard again showed that they can generate a correct response for questions that have an open-ended format.

Question 3: Students had to calculate the electrical force on an electron placed between two charged parallel plates. This calculation had two steps, and students achieving the acceptable standard were expected to answer the question correctly. They continued to do well with routine single- or two-step problem-solving questions. This question required students first to calculate the electric field strength between the parallel plates and then to convert to force by multiplying by the charge on an electron. Of the students who achieved the acceptable standard but not the standard of excellence, 77.7% answered the question correctly. Of the students who achieved the standard of excellence, 95.2% answered the question correctly. Of the students who did not achieve the acceptable standard, only 38.0% answered the question correctly. And 5.5% of all students recorded an answer of 4. This suggests that these students solved for electric field strength $|\vec{E}|$ rather than electric force $\vec{F}_e$.

Two parallel plates with a separation of 6.0×10^{-3} m ave a potential difference of 120 V across them. The lectrical force on an electron placed between the lates, expressed in scientific notation, is $\times 10^{-w}$ N. The numerical value of the exponent is __________ .

Use the following information to answer question 6.

Reflection from a Satellite



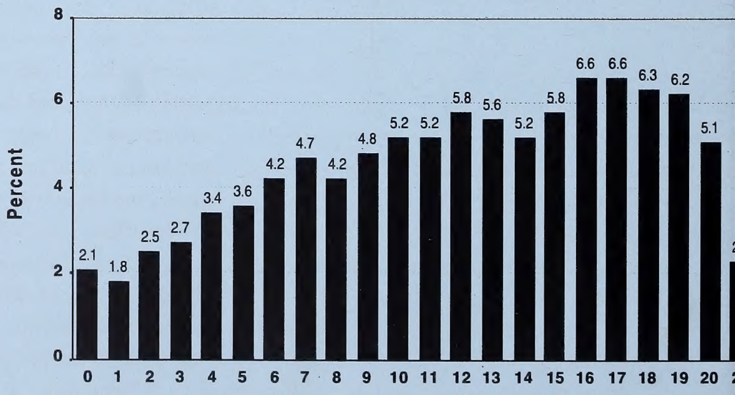
From each of the points A and B, the angle of elevation of the satellite is the same. Note: This diagram is not drawn to scale.

6. Neglecting the curvature of the Earth, if the time taken for a signal to travel from A to B via the satellite is 5.31×10^{-3} s, then the height of the satellite above the surface of the Earth is $b \times 10^{5}$ m. The value of b is ________.
(Round and record your answer to three digits.)

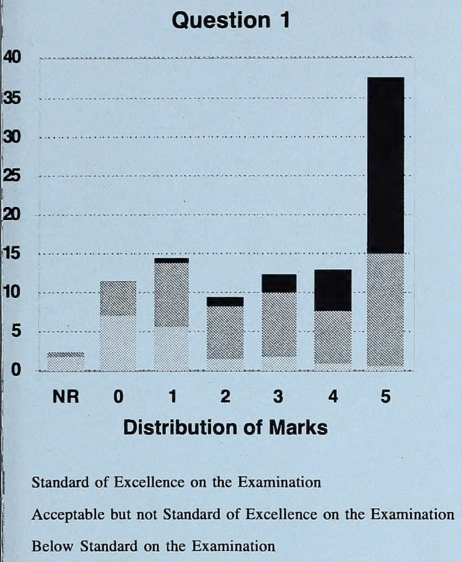
Question 6: Students had to calculate the height of a satellit above the surface of the Earth. To do this, students needed t calculate the straight line distance between the satellite and either point A or point B, and then use either the Pythagorea equation or the definition of cosine and sine/tangent to calculate the height. Students had to use the equation $d = vt$ This looks simple enough but to find the hypotenuse, studen had to divide the total time by two or the total distance by t and then apply the Pythagorean equation. Of the students w achieved the acceptable standard but not the standard of excellence, 60.3% answered the question correctly. Of the students who achieved the standard of excellence, 90.0% answered the question correctly. Of the students who did n achieve the acceptable standard, only 20.4% answered the question correctly.

Written Response

The four questions in the written-response section relate to f of the five strands for Physics 30. Responses to this section indicated that students approached the examination seriousl All four questions were attempted by 90.7% of the students very few, 0.4%, did not attempt any of the four questions. few students, 2.3%, achieved full marks on each of the four questions. Approximately 60.8% of the students obtained 1 or more marks out of 21. The average mark on the written-response section was 11.9 or 56.7% of the available marks.

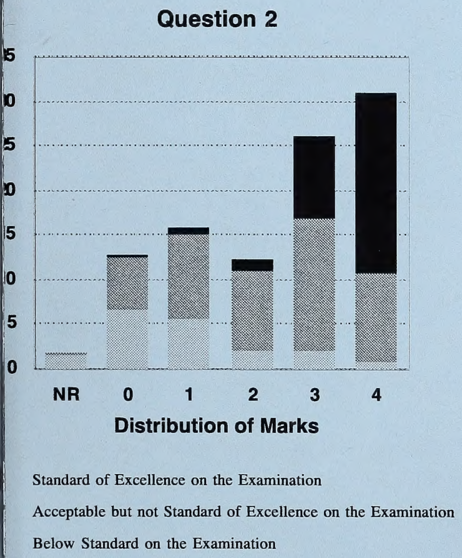


Distribution of Marks for Written Response



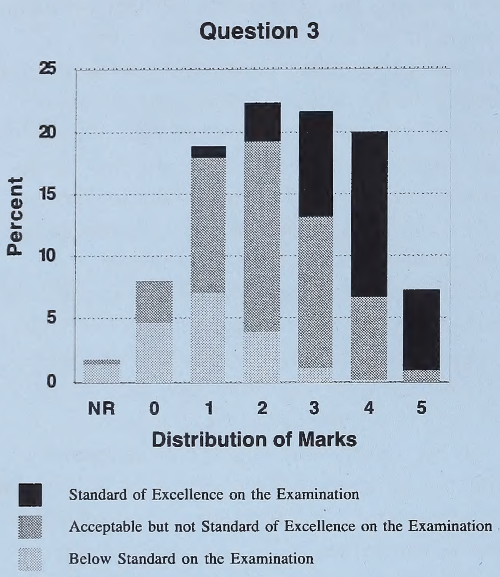
Question 1: Students were required to calculate the radius of curvature of photoelectrons in an external magnetic field. This was a three-step problem. Students first had to find the kinetic energy of the photoelectrons, then the speed, and finally the radius of curvature. The average mark on this question was 61.8%. Student achieving the acceptable standard, but not the standard of excellence, successfully determined the maximum kinetic energy and speed of the photoelectrons. They did, however, experience difficulty when required to derive an equation needed to determine the radius of curvature of the fastest electrons. Students achieving the standard of excellence had little problem with this question. Few students used the hypothetical value provided in the note below the question. Of the students who achieved the acceptable standard but not the standard of excellence, 58.8% received 3 or more marks out of 5. Of the students who achieved the standard of excellence, 94.7% received 3 or more marks out of 5. Of the students who achieved the standard of excellence, 70.9% received 5 out of 5 marks.

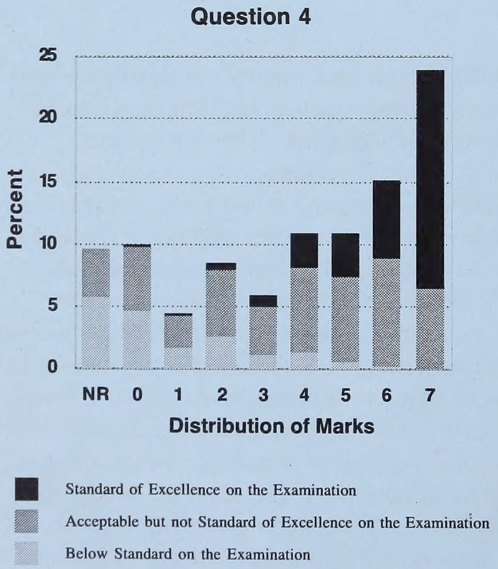
On this 5-mark question, the average mark was 3.09 or 61.8%.



Question 2: Students were required to calculate the mass of the Earth given the period of a satellite and its height above the surface of the Earth. Although students achieving the acceptable standard were expected to, many were unable to find the gravitational force, and therefore the centripetal force, because they did not add the height above the Earth to the Earth's radius to find the total radius. Of the students who achieved the acceptable standard but not the standard of excellence, 68.6% received 2 or more marks out of 4. Students achieving the standard of excellence were able to determine the total radius with little difficulty. However, after equating centripetal force to gravitational force, fewer students than expected were successful in manipulating the equation to solve for the mass of the Earth. Of the students who achieved the standard of excellence, 96.6% received 2 or more marks out of 4 and 63.8% received 4 out of 4 marks.

On this 4-mark question, the average mark was 2.44 or 61.0%.





Question 3: Students were given a graph and were required calculate the slope and show how the unit C was obtained fr the units in step 6. In part b, many students had difficulty deriving units. In part c, many students chose to do a calculation rather than read the value of the mass from the graph. It's still amazing that many students achieving the acceptable standard and the standard of excellence cannot re from the line of the graph to calculate the slope. Instead, students either use data points that are not on the line or sim do not accurately read the scales for the horizontal and verti axis. Of the students who achieved the acceptable standard not the standard of excellence, 39.5% received 3 or more ma out of 5. Of the students who achieved the standard of excellence, 87.3% received 3 or more marks out of 5 and 19.9% received 5 out of 5 marks.

On this 5-mark question, the average mark was 2.44 or 48.8

Question 4: Students were required to explain how they wo find the range of frequencies of the visible colours that are present in a non-monochromatic light source. Students kne that a double slit, grating, or a prism would cause light to disperse. But after this point, many students did not know what to do. Of the students who achieved the acceptable standard but not the standard of excellence, 57.5% received or more marks out of 7. Students achieving the acceptable standard were able to list materials and initiate a procedure t could be used to find the range of frequencies. However, knowledge of the values to be measured within the procedu was weak, and many students did not continue to answer the question completely. Students achieving the standard of excellence experienced some difficulty specifying what sho be measured and how to detect the pattern produced. Of the students who achieved the standard of excellence, 93.9% received 4 or more marks out of 7 and 54.2% received 7 out 7 marks.

On this 7-mark question, the average mark was 3.97 or 56.7

For further information, contact Greg Hall or Lowell Hackm at the Student Evaluation Branch, 403-427-0010.

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